DOE Hydrogen Program

Hydrogen Distribution and Delivery Infrastructure

Most of the hydrogen used in the United States is produced at or very near where it is used — typically at large industrial sites. As a result, our nation does not yet have a cost-effective and energy-efficient infrastructure for delivering large quantities of hydrogen fuel over long distances. Before hydrogen can become a mainstream energy carrier and used widely by consumers, we must build the infrastructure needed to distribute it.

How Is Hydrogen Delivered Today?

Suppliers currently transport hydrogen by pipeline or by road using tube trailers and cryogenic liquid hydrogen tankers. For special purposes, liquefied hydrogen is transported by barge. Hydrogen also can be moved using carriers — chemical substances that incorporate atoms of hydrogen and other elements — such as ethanol or ammonia.

- Pipelines are the least expensive way to deliver large volumes of hydrogen, but the current hydrogen pipeline infrastructure in the United States is very small (approximately 700 miles, compared to more than one million miles of natural gas pipelines). Hydrogen pipelines currently exist in just a few regions, near large petroleum refineries and chemical plants in Illinois, California, and the Gulf Coast.

- Transporting compressed hydrogen gas over the road in high-pressure tube trailers is expensive and used primarily for short distances; it becomes cost-prohibitive when transporting farther than about 200 miles from the point of production.

- Liquefied hydrogen (cooled to -423°C) is denser and has a higher energy content than gaseous hydrogen in a given volume (such as a tank), so it is preferred for delivering hydrogen over long distances, when compared to delivery by tube trailer. Liquefaction is costly and takes a great deal of energy. Nonetheless, because current pipeline transport has limited availability, hydrogen is often transported as a liquid in super-insulated, cryogenic, over-the-road tankers and then vaporized for use at the customer site.

What Are the Challenges?

Hydrogen has a low volumetric energy density — it contains a relatively small amount of energy by volume compared to other fuels such as natural gas and gasoline — so its transportation, storage, and final delivery to the point of end-use are costly and result in some of the energy inefficiencies associated with using it as an energy carrier.

- The high initial capital costs of new pipeline construction constitute a major barrier to expanding hydrogen pipeline delivery infrastructure. Technical concerns related to pipeline transmission include the potential for hydrogen to embrittle the steel and welds used to construct pipelines, and the need for lower cost, more reliable, and more durable hydrogen compression technology. Also, because hydrogen molecules are very small, preventing permeation and leakage from pipeline and other containment materials is a challenge.
- How hydrogen is produced also affects the cost and method of delivery. Producing hydrogen in large, central plants (as far as several hundred miles from the point of end-use) results in longer transport distances that increase delivery costs. Distributed production at the point of end-use, such as refueling stations or stationary power sites, eliminates the transportation costs, but results in higher production costs.

Research Directions

Researchers are working to better understand the options and trade-offs for hydrogen delivery from central, semi-central (25 to 100 miles from the point of end-use), and distributed production sites.

Research is also focused on developing:

- Lower-cost, more reliable hydrogen compression technology;
- More cost-effective bulk hydrogen storage technology;
- New materials for lower-cost hydrogen pipelines;
- More energy-efficient and lower-cost hydrogen liquefaction processes; and
- Integrated production, delivery, and end-use technologies.

A hydrogen economy requires an infrastructure to deliver hydrogen from where it's produced to the point of end-use, such as a dispenser at a refueling station.

Photo courtesy of Air Products and Chemicals, Inc.

Building a national hydrogen delivery infrastructure is a big challenge. It will take time to develop and may include various combinations of technologies. Delivery infrastructure needs and resources will vary by region and type of market (e.g., urban, interstate, or rural). Infrastructure options will also evolve as the demand for hydrogen grows and as delivery technologies develop and improve.

Did you know...

Hydrogen is an energy carrier, not an energy source, meaning that it stores and delivers energy in a usable form.

Hydrogen can be produced using abundant and diverse domestic energy resources, including fossil fuels, such as natural gas and coal; renewable energy resources, such as solar, wind, and biomass; and nuclear energy.

A hydrogen economy would not only reduce our dependence on imported oil, but also benefit the environment by reducing emissions of greenhouse gases and criteria pollutants that affect our air quality.

The President's Hydrogen Fuel Initiative accelerates the research and development of hydrogen, fuel cell, and infrastructure technologies that would enable hydrogen fuel cell vehicles to begin to reach the commercial market in the 2020 timeframe.

Under the President's Hydrogen Fuel Initiative, the DOE Hydrogen Program works with industry, academia, national laboratories, and other federal and international agencies to overcome critical technology barriers, address safety issues and facilitate the development of model codes and standards, validate hydrogen fuel cell technologies in real world conditions, and educate key stakeholders in the transition to a hydrogen economy.